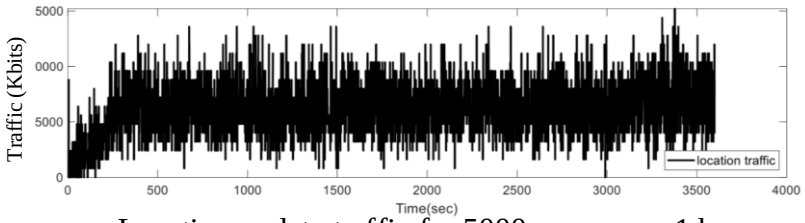
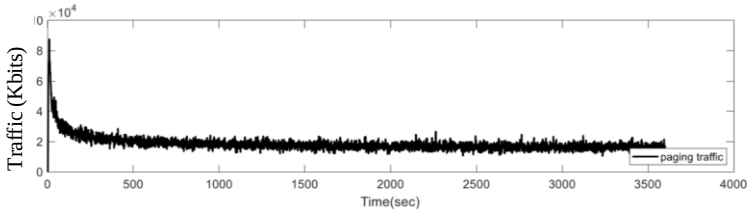
1. Frequency hopping is one technology used in the GSM system. Please explain the main advantage of applying Frequency hopping in GSM by applying one simple example. (10%)

2. There is a 10*10 km area covered by 100 BTSs, and the coverage of each BTS is 1 km*1 km. The area is further divided into 25 location areas (LAs), and the size of each LA is 2 km*2 km. There are 5,000 mobile users (MUs) in the area. The movement of each mobile user follows the **random waypoint model**[1]. Initially, all the mobile users are uniformly distributed over the network. Once a mobile user crosses the boundary of the two LAs, the mobile user will update its location, which generates 800 Kbit network traffic. Assume that voice call arrivals for each mobile user follow a Poisson distribution with the average arrival rate equal to 0.0125 call/second. The network traffic generated by the paging process is 60 Kbit* N (where N is the number of the BTSs in an LA.).

    a) Simulate the whole procedure to calculate the generated location update traffic and paging traffic in 1 hour, and draw the related graph (find the sample graphs as follows). (45%)



Location update traffic for 5000 users over 1 hour.



Paging traffic for 5000 users over 1 hour.

    b) Change the size of an LA to be 1 km*1 km, 3 km*3 km, and 5 km*5 km, respectively. Find the generated location update traffic and paging traffic in 1 hour, and draw the related graphs. (45%)

Please submit a report as well as the program code. You are free to your preferred program platform and language (e.g., MATLAB, Python, c, etc.).

[1] For each mobile user, a destination should be selected. Once the destination is selected, the mobile user will move directly along straight line from its current location to the selected location. The speed of each mobile user is uniformly selected from (0, 10m/s) in each second. The location of each mobile user should be updated in each second. Once a mobile user arrives at its destination, a new destination will be selected.